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Infrastructure Planning for the Port of Los Angeles:

Case Study for Incorporating Climate Science into Planning Process

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Climate Change Impacts on Transportation System

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Overview

This study:

- Helped the Port of Los Angeles evaluate the extent to which potential extreme sea level rise ought to affect their infrastructure investment decisions
- Demonstrates a widely useful approach for including information on climate extremes in vulnerability and risk assessments

Managing Climate Risk Poses Both Analytic and Organizational Challenges

Climate-related decisions involve:

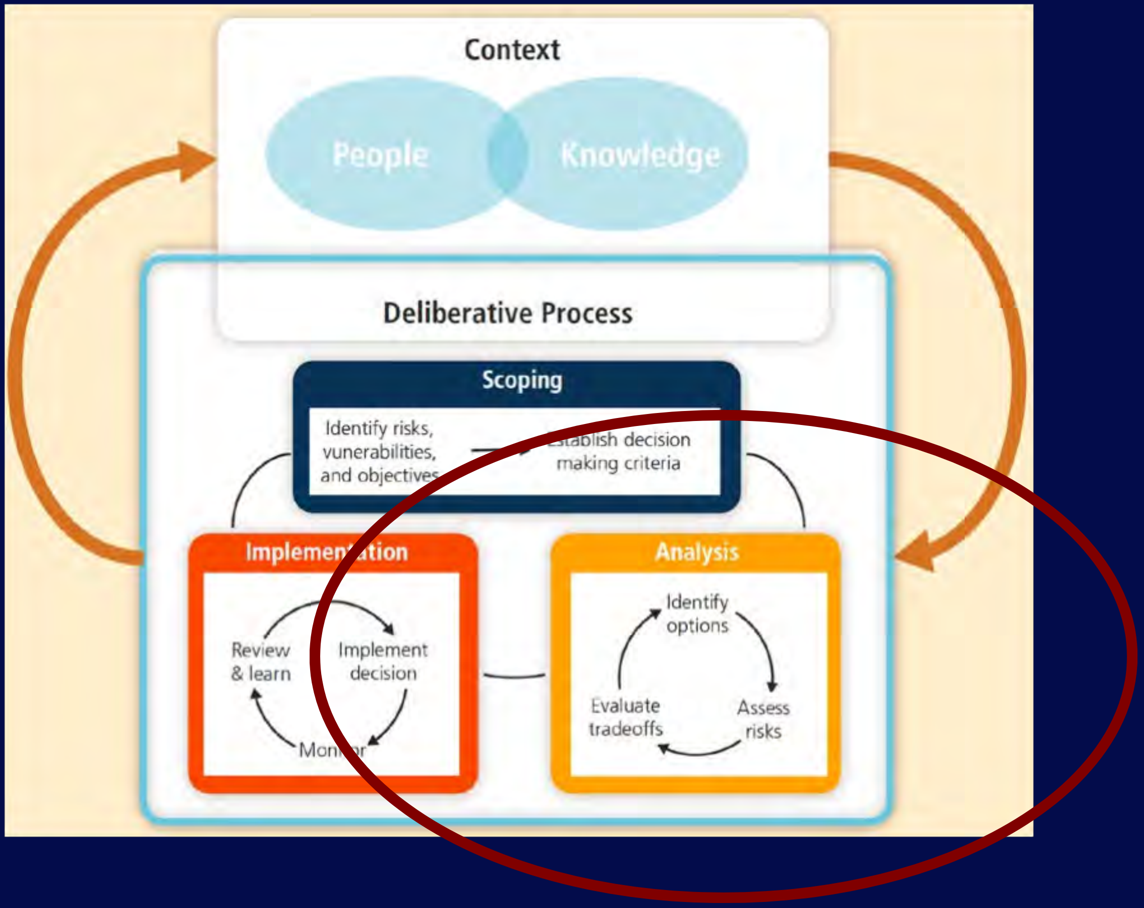
- Incomplete information from new, fast-moving, and sometimes irreducibly uncertain science
- Many different interests and values
- Long-time scales
- Near certainty of surprise

Public planning should be:

- Objective
- Subject to clear rules and procedures
- Accountable to public

How to make plans more robust and adaptable while preserving public accountability?

Iterative Risk Management is a Useful Framework for Climate Change Adaptation



Risk = Probability x Consequence

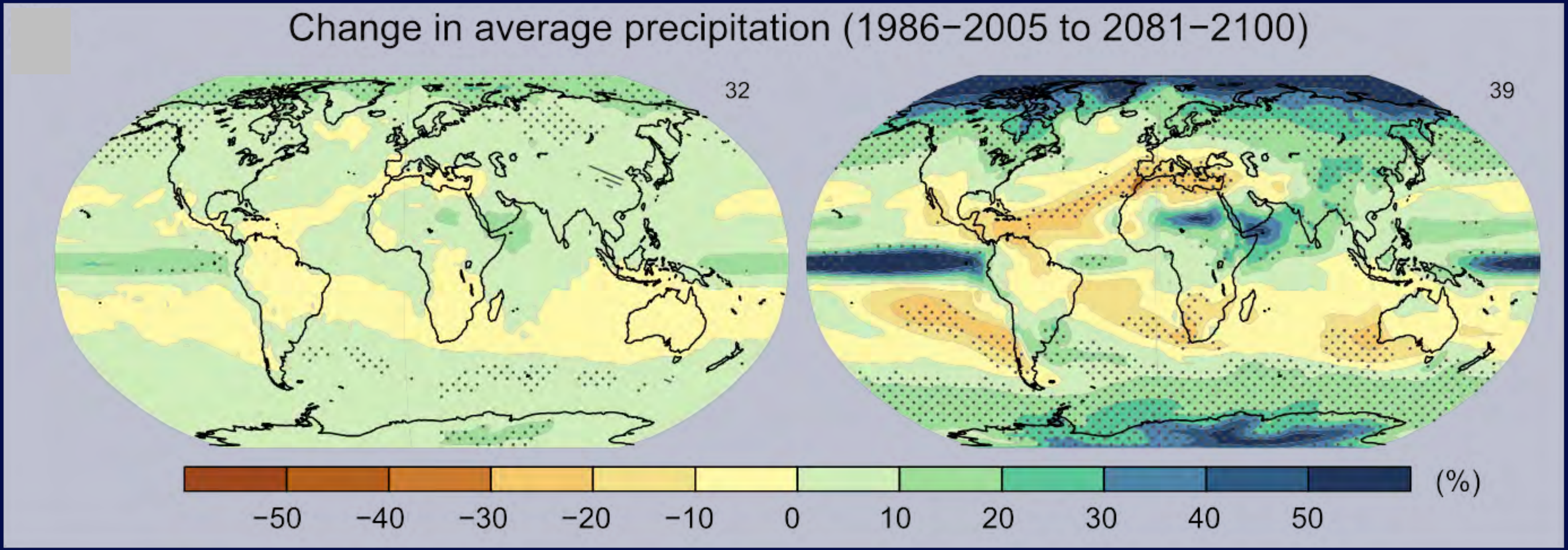
But in general, both terms are at best known imprecisely

How best to include climate information in this process?

Source: Working Group II: IPCC Fifth Assessment Report (2014)

Our Climate is Changing in Sometimes Hard-to-Predict Ways

IPCC Fifth Assessment report multi-model projections of precipitation changes



Lower emissions scenario (RCP 2.6)

Higher emissions scenario (RCP 8.5)

Deep uncertainty occurs when the parties to a decision do not know or do not agree on the likelihood of alternative futures or how actions are related to consequences

Traditional Risk Assessment Methods Work Well When Uncertainty is Limited

"Agree on Assumptions" Approach"

What will future conditions be? → **What is the best near-term decision?** → **How sensitive is the decision to the conditions?**

But under conditions of deep uncertainty:

- **Uncertainties are often underestimated**
- **Competing analyses can contribute to gridlock**
- **Misplaced concreteness can blind decisionmakers to surprise**

Under Deeply Uncertain Conditions, Often Useful To Run the Analysis Backwards

“Agree on Assumptions”

What will future conditions be?

What is the best near-term decision?

How sensitive is the decision to the conditions?

“Agree on Decisions”

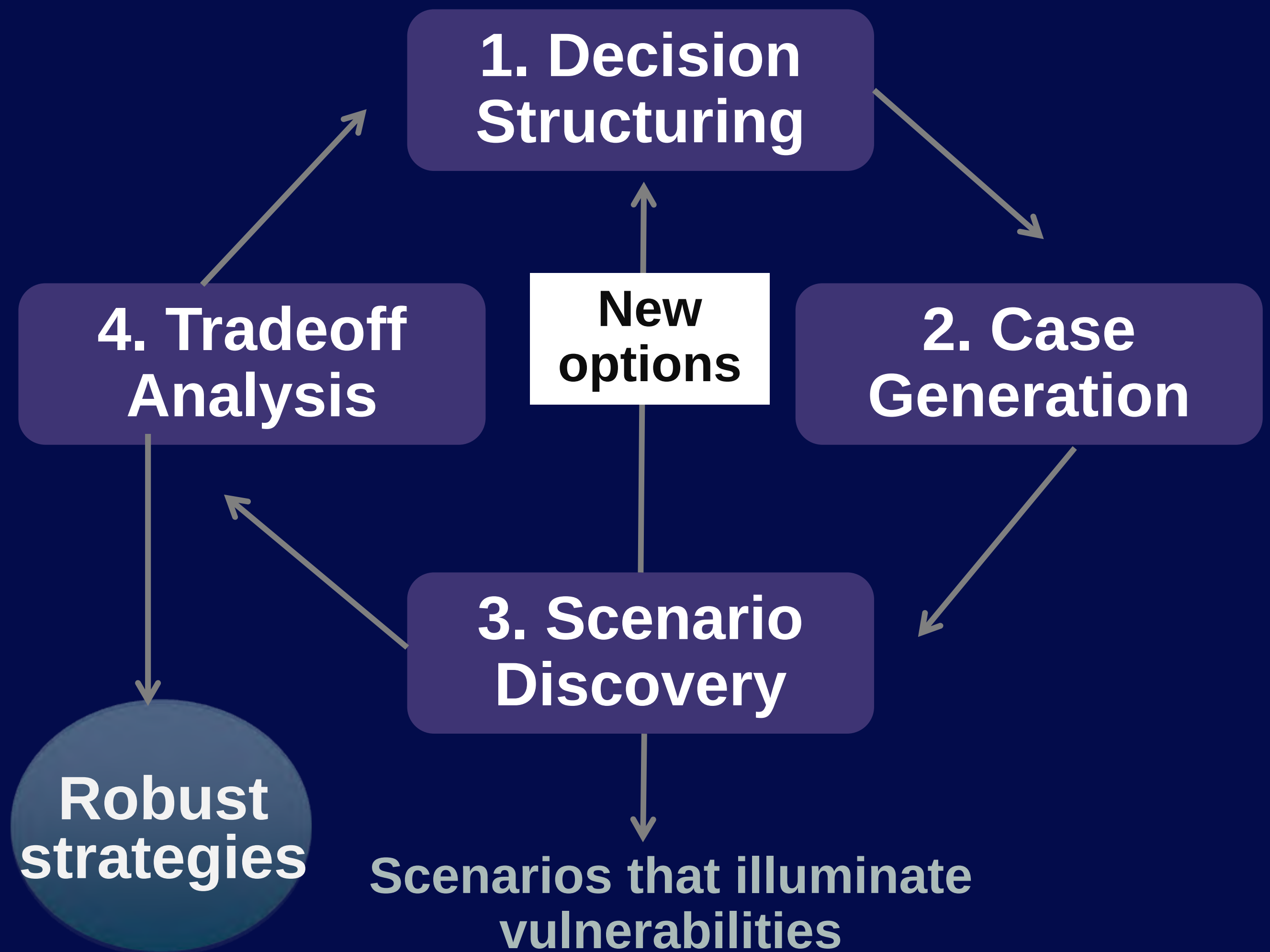
Proposed strategy

Identify vulnerabilities of this strategy

Develop strategy adaptations to reduce vulnerabilities

Robust Decision Making (RDM) Provides Such an "Agree on Decisions" Approach

RDM is *iterative*; analytics facilitate stakeholder deliberation



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Should the Port of Los Angeles (PoLA) Harden Its Terminals Against Extreme Sea Level Rise at the Next Upgrade?
Yes. Hardening at the next upgrade is much less costly than discovering in the future that we are unprepared.
No. Our terminals are only vulnerable to *extreme* sea level rise and storm surge. Let's wait.
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If We Harden at Next Upgrade, Do Net Benefits Exceed Costs?

Calculate net present value (NPV)

NPV = Discounted Benefit - Discounted Cost

Discounted Benefit → (Avoided Cost of Reactive Future Response)

Discounted Cost → (Cost of Hardening at Next Upgrade)

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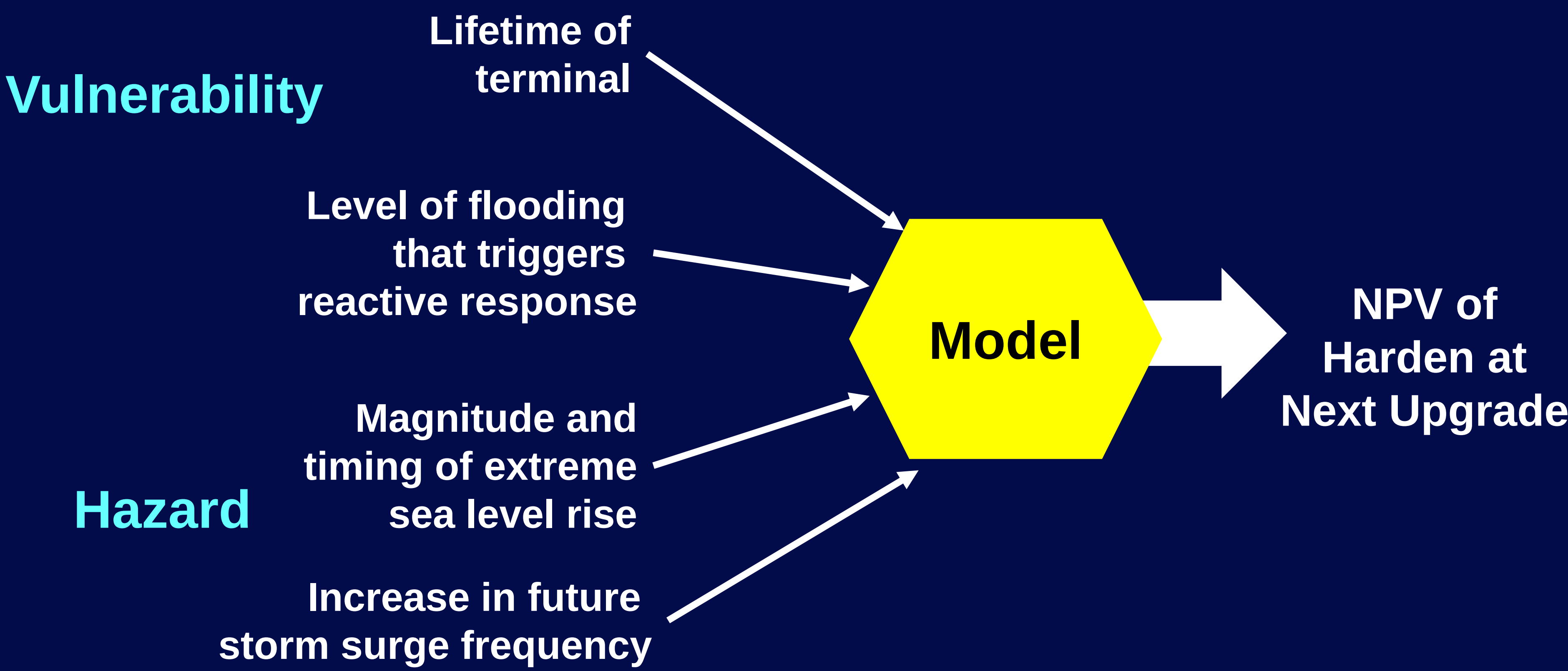
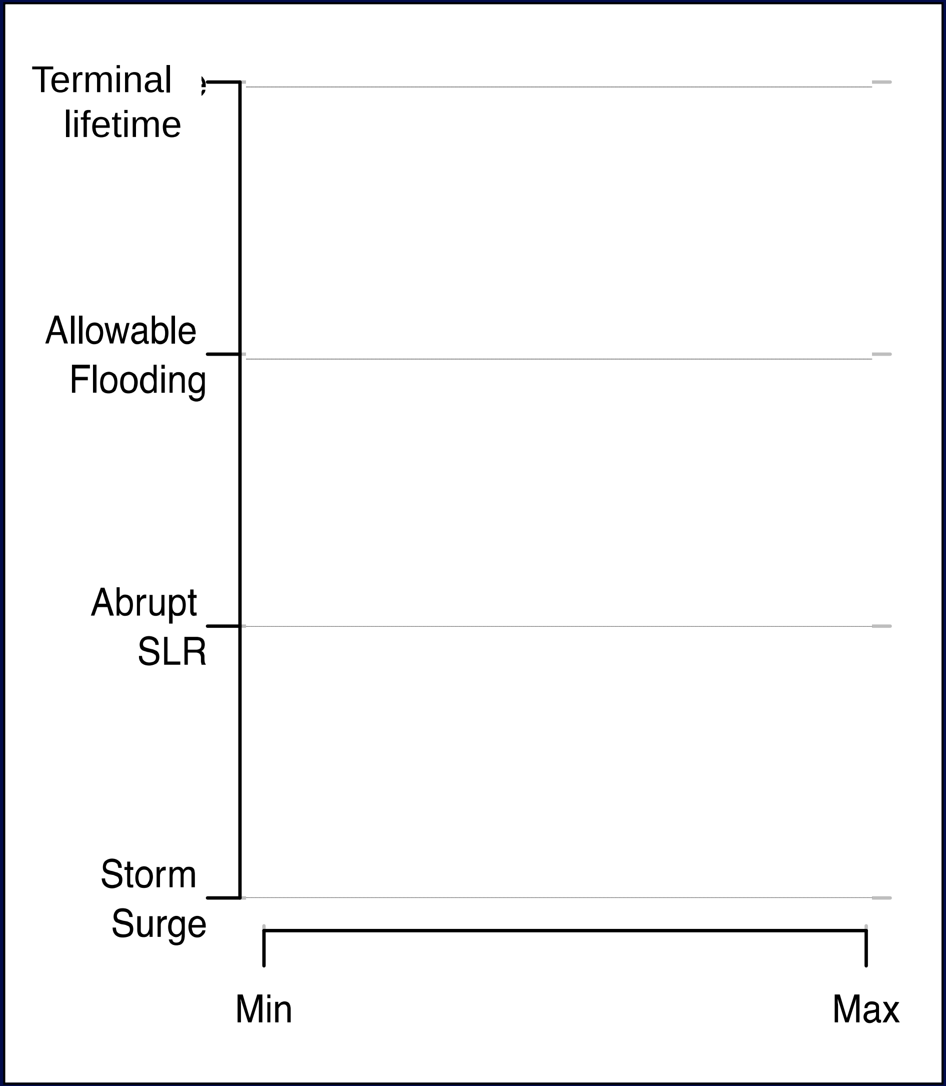
Cost Benefit Calculation Depends On Four Parameters About The Future



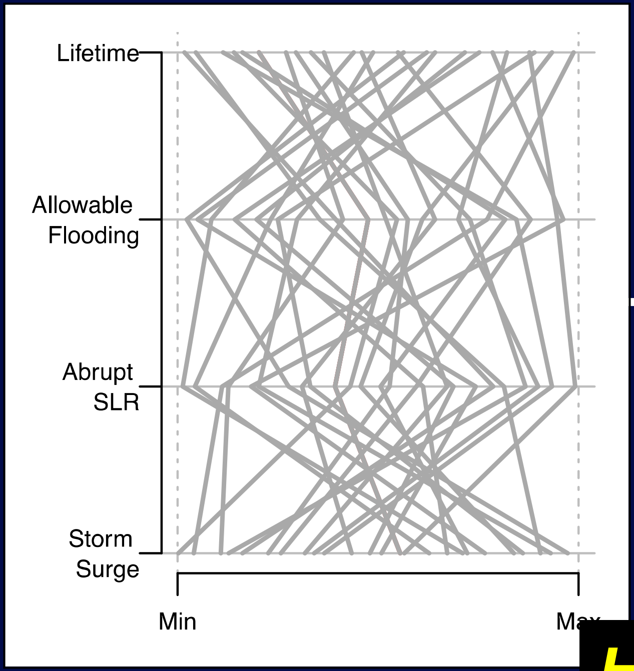
R. Lempert, R Sriver, and K Keller. 2012. "Characterizing Uncertain Sea Level Rise Projections to Support Investment Decisions." California Energy Commission. CEC-500-2012-056

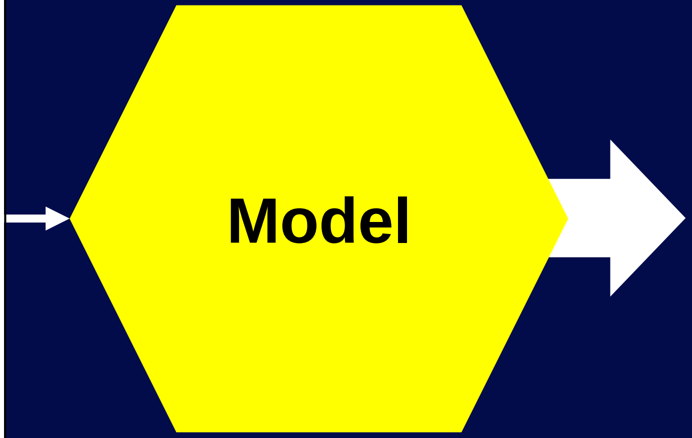
Each Parameter Could Take On A Plausible Range Of Values



Let's Examine The NPV of Hardening For Many Alternative Futures

Considered 500 Futures





NPV of early hardening in each of 500 futures

Helps reduce gridlock:
Each stakeholder's expectations can be one of our futures.

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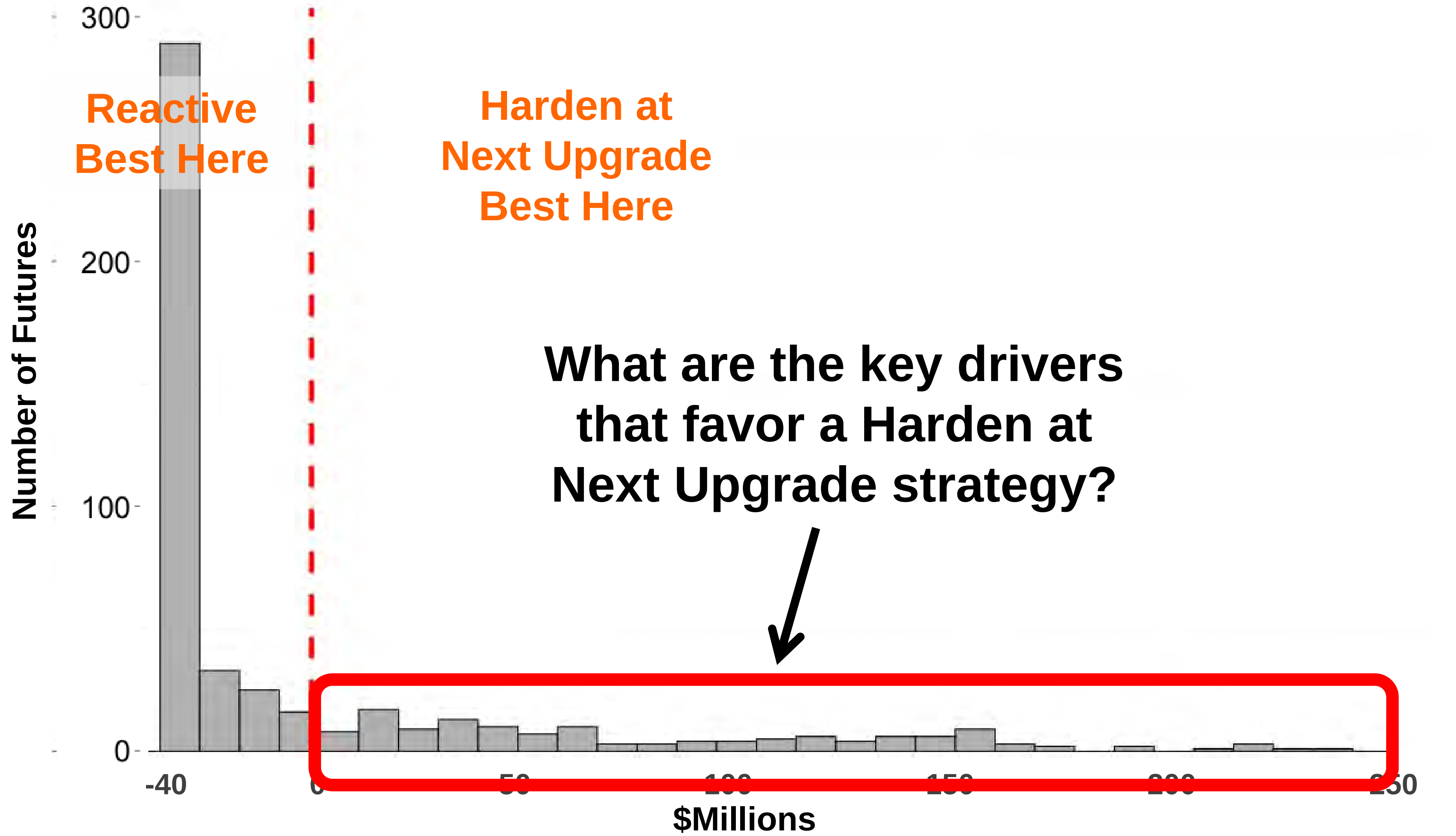
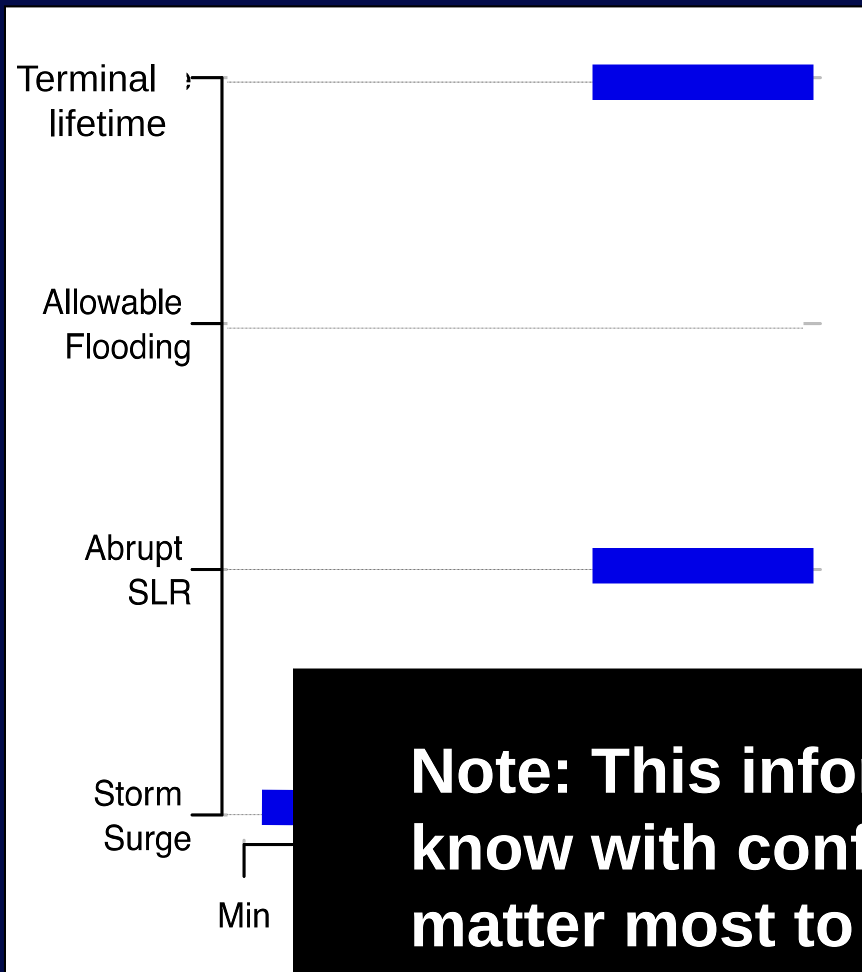
Consider Range of Performance Over These Futures



Summarize Conditions Where Harden Strategy Passes Cost-Benefit Test

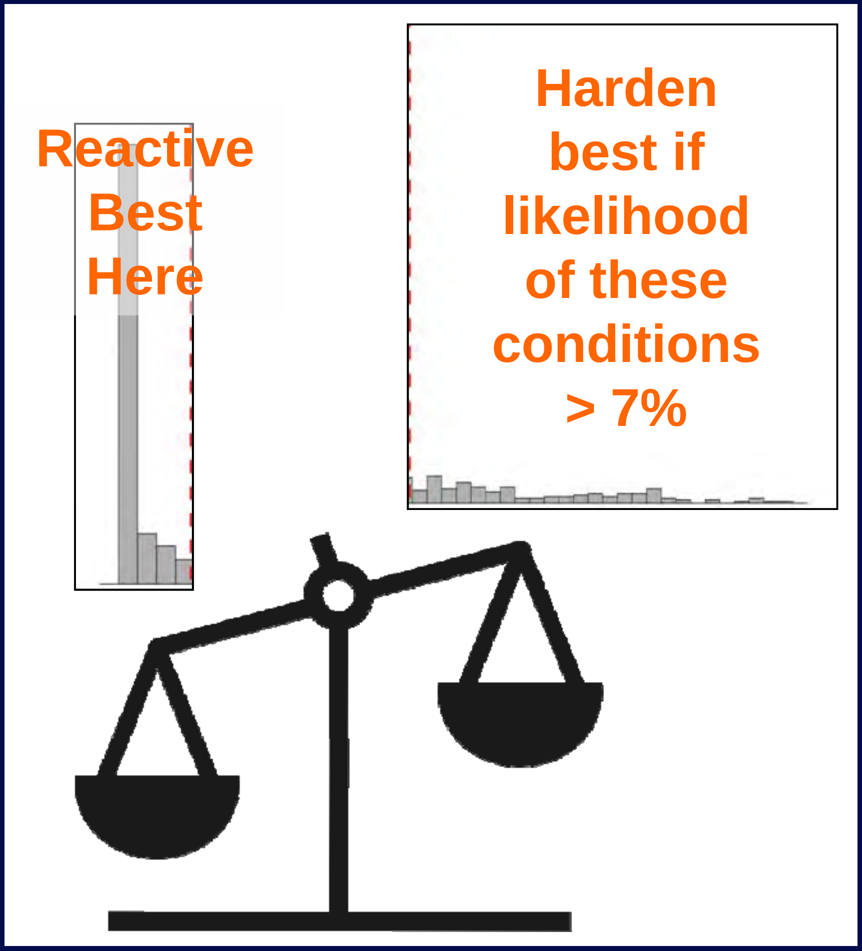


IF
- Abrupt SLR > 14mm/yr
- Lifetime > 75 years
- Storminess change > +5%

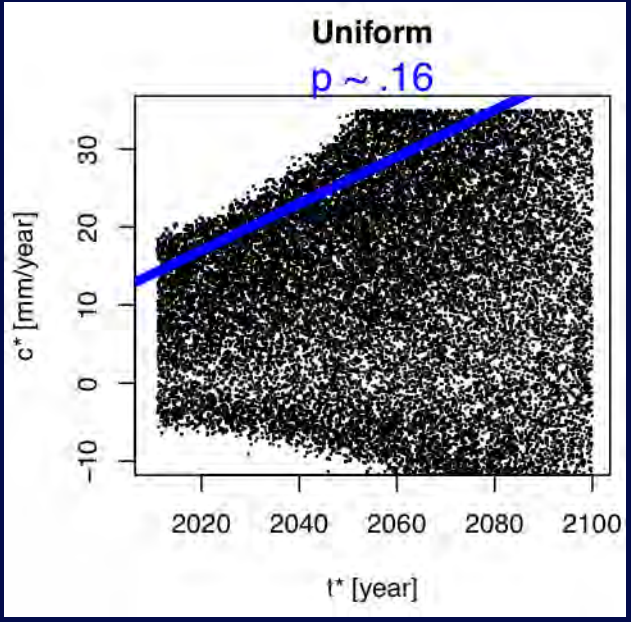
THEN
- Hardening at the next

Note: This information is something we can know with confidence – the conditions that matter most to our decision

Little Evidence to Suggest These Conditions Sufficiently Likely To Justify Hardening Terminals at Next Upgrade

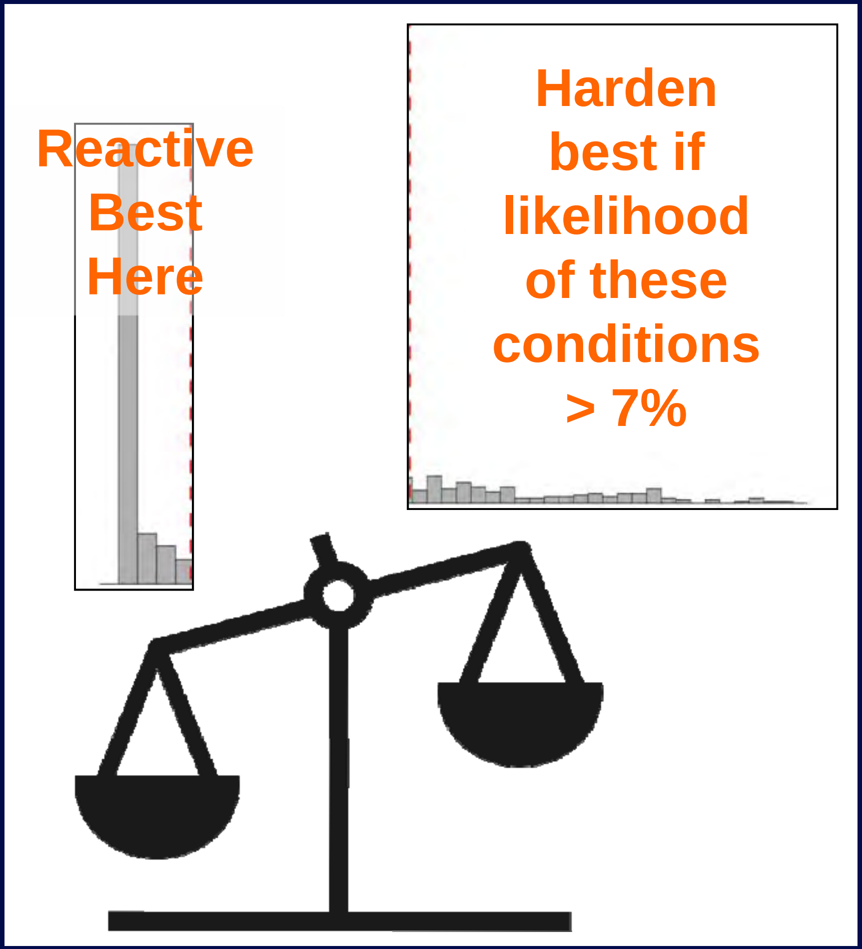


- Best science suggests likelihood of fast SLR < 16%



Use statistical fits to physically-based bounding analyses for maximum rates of sea level rise.

Little Evidence to Suggest These Conditions Sufficiently Likely To Justify Hardening Terminals at Next Upgrade



- Best science suggests likelihood of fast SLR < 16%
- No PoLA experience with lifetimes as long as 75 years
- No study suggests storminess increase of 5%

But for some PoLA infrastructure, hardening at the next upgrade may be appropriate

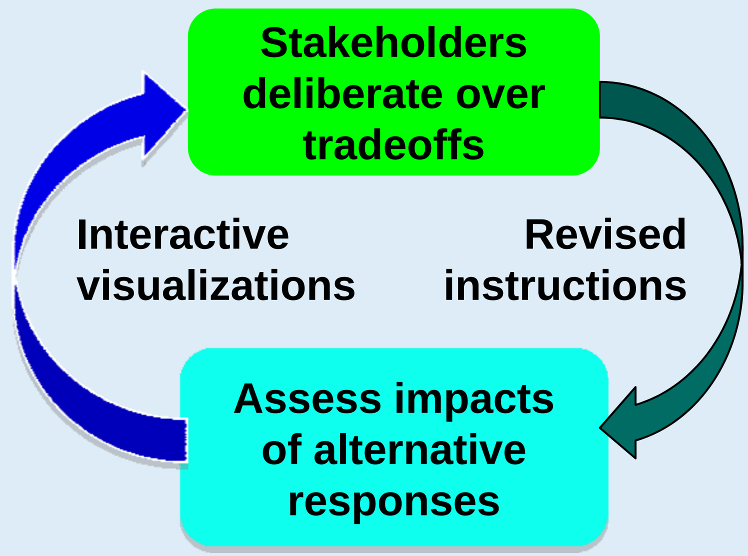
“Agree on Decisions” Approach to Climate Risk Management Facilitates Stakeholder Deliberation

Approach used for:

- Bureau of Reclamation Colorado Basin Supply and Demand Study
- Louisiana Master Plan for a Sustainable Coast
- World Bank
- Current work in Jamaica Bay

In Louisiana

Dozens of workshops with many stakeholders over two years



Planning Tool and Risk Assessment Model

Helps generate consensus on potential risks and provides structure for developing adaptive management plans

Observations

- Protecting critical infrastructure from hard-to-predict risks requires integrated and adaptive management
- Conducting the analysis “backwards (stress testing proposed strategies over many futures):
  – Helps reduce prediction bias and the risks of the surprise
  – Facilitates integrated planning
  – Helps open the process to stakeholder deliberation

More Information

R. Lempert, R Sriver, and K Keller. 2012. “Characterizing Uncertain Sea Level Rise Projections to Support Investment Decisions.” California Energy Commission. CEC-500-2012-056

http://www.rand.org//pardee/

Thank you!